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Creating an ASEAN Gas Market: Infrastructure, Interconnections, and Innovative Technological Solutions

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Indonesia remains a world leader in LNG

- A major experienced supplier
- New potential
- A Leading part in new generation LNG
 - Regasification conversion at Arun
 - FLNG at Abadi
 - FSRUs
 - Small scale LNG distribution

Is there a new golden era for natural gas?

- YES, there is a new era.
 - There will be more gas
 - Climate change is real
 - Natural gas is the viable pathway to a lower carbon future
 - Marine Environmental legislation is irreversible
 - New technologies are being applied now
- MAYBE it will be “golden.”
 - Much depends on how market reacts
 - And on “black swans.”

Some New Gas Infrastructure Supply and Distribution Technologies

FLNG

FLRSUs

FRSUs

Gravity based near shore terminals

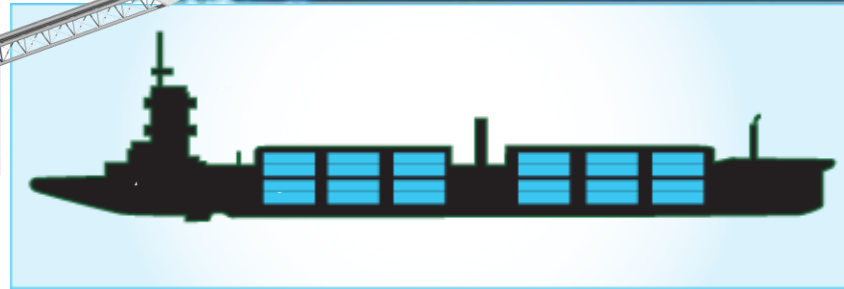
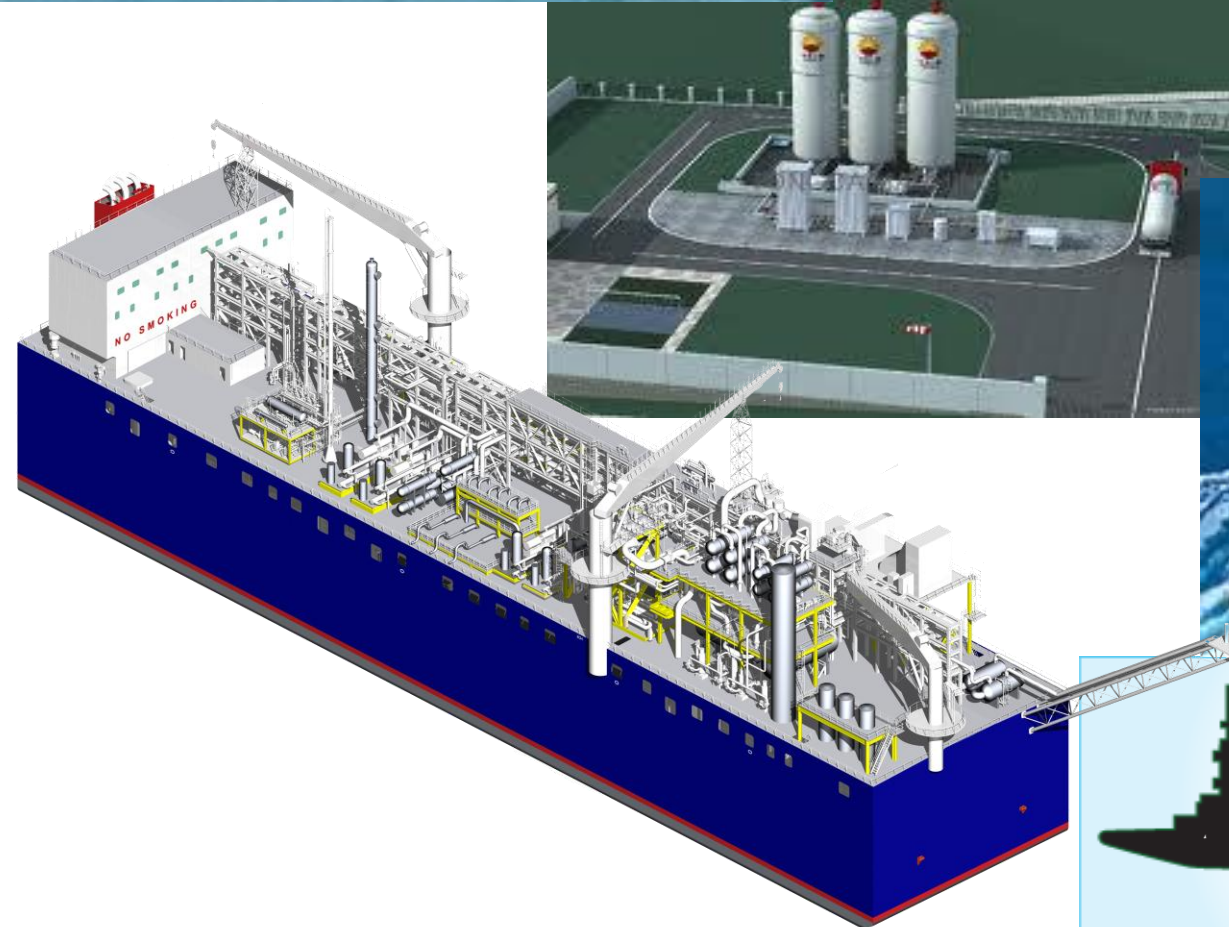
Small scale Liquefaction

“LNG/CNG in a Box”

Articulated LNG Barges

Containerised LNG

CNG



CNG

- CNG = natural gas compressed at 275 BAR and ambient temperature.
- LNG = natural gas liquefied at -162° and ambient pressure.
- LNG volume = $1/600^{\text{th}}$ of natural gas, so 2+ x energy of CNG in same fuel tank. CNG needs small volumes and short distances to market.
- No CNG ships in operation but CNG marine cargo tank and ship design now developed and has class approval.
- Challenge of financing and risk allocation along supply chain.
- Long CNG experience in commercial vehicle and car market. Ideal for short haul vehicles, with daily fuelling e.g. urban buses.
- CNG can be supplied to this market off back of LNG distribution chain.

A Schematic Infrastructure Picture



Opportunities: FLNG/FSRUS plus small ships and/or barges

- Use of small LNG ships and barges to distribute from mother vessel to local markets.
 - Gives scope for negotiation on domestic supply obligations
 - Avoids large scale onshore developments
 - These can be costly and create huge social, economic and political problems
 - But still enables planning of local economic development
 - Volumes supplied in manageable quantities
 - Scale up is easy as economic development progresses

Added Advantages of Barges

- Articulated barges have added advantage of cost saving and flexibility
 - Barges can act as floating storage at delivery points
 - Also as re-gas and power generation plants
 - ‘Swap and drop’ maximises use of vessel capacity
 - With multiple locations ‘hub and spoke’ operations are possible, using x barges and x-y, tugs
 - Barges and tugs can be built in local shipyards
 - Barges can be easily sized to match market
 - Scale up is easier to achieve
 - Shallow drafts

The Potential from Abadi



Opportunities for existing and new onshore plants and terminals

- LNG handling and vessel management procedures for smaller vessels and barges are being developed in Europe and US.
- Designs for barges can be made to match existing terminals with only modest terminal investment
- Existing terminals can become hubs for regional small scale supply, e.g.
 - Arun to Western Sumatra
 - Brunei to Philippines

Opportunity for “stranded” gas field development

- LNG plants can be transported to land based isolated small gas fields that cannot support pipeline
 - LNG/CNG in a box
 - Modular LNG plants of significant size delivered by container
- LNG can be exported from field
 - In containers by truck
 - In small bulk or containers by barge
 - Designed for shallow draft inland waters.

Opportunities to develop new local power and fuel markets

- Access to modern energy is the number one aspiration of local communities affected by major energy projects
- Small scale LNG can meet this aspiration by supplying to small generators to create local electricity distribution
 - Delivery by small bulk ship or barge, especially where navigable water connects supply and off-take locations
 - Containerised LNG ideal for micro markets, shallow inland water locations and road delivery.
 - Enables substitution of diesel
 - Immediate economic, environmental and social benefits

Opportunities for gas in road transport

- Major push US for LNG as heavy road vehicle and locomotive fuel
 - Clean Energy is an established player liquefying supply off pipeline gas
 - Shell (and others) now entering market
 - Modular small scale LNG plants on shale gas fields
 - Working with engine manufacturers on engine designs
 - Working with fuel chains to establish filling station networks
 - LNG ideal for long haul vehicles
 - CNG better for short hauls and domestic vehicles
 - But CNG readily delivered off the back of LNG distribution network

Clean Energy's Natural Gas Fueling Network



Marine, the biggest new market for natural gas?

- LNG as a marine fuel offers huge potential
- ASEAN region ideally located to capture a big share of this potential
- IMO and regional environmental directives are driving ship owners to assess use of LNG
- Technical and safety issues are being addressed
 - Location of fuel tanks
 - Bunkering operations
- Economics for conversion of existing ships are not clear
 - Trade off between loss of cargo space and cheaper fuel
 - Option of scrubbers to meet new emission standards
 - Uncertainty on future natural gas prices
- But new build for vessels operating entirely within emission control areas is happening
 - Baltic, North Sea, English Channel
 - European inland waterways
- Major US shipper has announced plans for four large new LNG fuelled container ships
 - Establishment of LNG bunkering in US priced off US gas prices will stimulate global LNG fuelled shipping

Emission Control Areas



Conclusion

- We are in a new era for natural gas.
- To quote a major IOC, natural gas will be “available, affordable and acceptable.”
- Technologies to take advantage of this are being developed rapidly.
- This creates a wide range of opportunities.
- These opportunities include
 - New markets for gas
 - The development and export of new gas technologies
 - New options for managing resource development
 - New options for managing local and regional development
 - Environmental improvements
 - Tools to support management of climate change
- All this is good news for ASEAN and Pacific nations
 - This development provides new ways to address pressing needs
 - They are well placed to take economic advantage of market opportunities